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Project Number 7752

Mr. James Shafer
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10 Industrial Highway, Mail Stop 82
Lester, Pennsylvania 19113

Reference: CLEAN Contract No. N62472-90-D-1298
Contract Task Order No. 0302

Subject: Plan for Human Health Risk Assessment Derecktor Shipyard (Off-Shore)

Dear Mr. Shafer:

Enclosed are four copies of the Plan for Human Health Risk Assessment For Off-Shore Areas of Derecktor Shipyard. Brown and Root Environmental hopes to present the results of this risk assessment at the EAB meeting at the end of January. Comments from the regulators can be addressed as the work is completed, rather than in a revision of the plan.

If you have any questions regarding this material, please do not hesitate to contact me.

Very truly yours,

Stephen S. Parker
Project Manager

SSP/

attachment

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PLAN FOR HUMAN HEALTH RISK ASSESSMENT
FOR THE
OFF-SHORE AREAS OF THE FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

This plan provides a description of the human health risk assessment (HHRA) methods planned for use for evaluating data collected from the marine environment of Coddington Cove, near the former Robert E. Derecktor Shipyard (Derecktor Shipyard). The objectives of the risk assessment are to estimate the actual or potential risks to human health resulting from the presence of contamination in shellfish tissue (mussels, clams and lobsters) and to provide the basis for determining the need for remedial measures in the Feasibility Study.

Introduction:

A description of the facility, its setting, and its surroundings are provided in the Study Area Screening Evaluation Report (SASE) (Draft Final, B&R Environmental, June, 1997). The Ecological Risk Assessment Report (ERA) (Final, SAIC and URIGSO May, 1997) provides a characterization of the off-shore conditions, including suitability and extent of aquatic habitats, tidal influences and movement, subsurface sedimentation, aquatic vegetation, diversity and abundance of shellfish, etc.

An evaluation of these two reports has been performed as a part of the preparation of this plan. This evaluation was performed to determine the media which should be addressed by the HHRA for the marine environment at the site. To summarize, Derecktor Shipyard is best characterized as an industrial port with deep water pier space along the waterfront. The water depths within the study area are between 20 and 50 feet. This precludes the potential for human exposure to contaminants in sediments in these areas. However, the waters are not restricted to boating traffic or commercial and private fishing. The ERA report identifies site contaminants in the

tissues of shellfish collected from the study area. Therefore there is a potential for human exposure to site contaminants present in shellfish.

The risk assessment will estimate the potential for human health risk attributable to ingestion of indigenous marine biota (shellfish) collected from stations near the Derecktor Shipyard. Information regarding the toxicity of the compounds detected in the evaluated media, the distribution of contamination, potential migration pathways, and a site-specific estimate of chemical intake via assumed exposure routes will be combined to estimate potential risks for Derecktor Shipyard. The risk assessment processes to be used for this study are consistent with current EPA risk assessment guidance (see the references attached). In addition, they will be performed according to methods used for the McAllister Point Landfill HHRA (Brown and Root Environmental, 1997), which was reviewed by EPA Region I and RIDEM.

The use of exposure parameters developed for the marine environment at McAllister Point Landfill was agreed to by the Navy for the sake of simplicity and conformance with other similar projects performed at NETC. However, this should be evaluated as a highly conservative assessment in that actual exposure parameter values that receptors would be subject to are anticipated to be much lower, based on the difficulty for collection of clams and mussels by subsistence fishermen and the restricted nature of the waters at this site. These issues will be examined in the uncertainty sections of the risk assessment report.

The human health risk assessment will consist of five sections: Data Evaluation, Toxicity Assessment, Exposure Assessment, Risk Characterization, and Uncertainty Analysis. Each section is briefly discussed below.

Data Evaluation

Data Evaluation presents the approaches for Data Analysis, Identification of Chemicals of Potential Concern (COPCs), and estimates of Exposure Point Concentrations (EPCs).

Occurrence and distribution of the site data has been previously presented in the Exposure Assessment section of the ERA report. This information will be summarized in the Data Evaluation section of the HHRA. The validated data will be used to calculate EPCs. The validated data will include those biota tissue samples collected between June 1995 and October 1995 by the University of Rhode Island and SAIC for the ERA. The tissue data collected included the following:

Indigenous blue mussel (*Mytilus edulis*), hard shell clams (*Mercenaria mercenaria* and *Pitar morrhuana*), lobster (*Homarus americanus*), cunner fish (*Tautoglabrus adspersus*), and mummichog fish (*Fundulus heteroclitus*).

The cunner fish and the mummichog fish are considered inedible for human consumption and will not be evaluated in the HHRA. Deployed mussels (used for the ERA) will also not be evaluated in this HHRA, because the indigenous blue mussels present in sediment are expected to represent more realistic or actual conditions for human consumption at Derecktor Shipyard.

Non-detected contaminant concentrations will be included in the calculation of EPCs. These non-detects include detection limits associated with a "U" or "UJ" qualifier, and will be assumed to be one-half of the SQL. Rejected values (R) will be eliminated from further consideration. Estimated values ("J" qualified) will be used as the reported value.

Duplicate samples will be averaged together and considered as one result. For duplicates, where one result is positive and the other result is a non-detect, the problem of calculating an average (arithmetic mean) result arises whenever half the detection limit exceeds the positive result. In these situations, the positive result will be used to represent the non-detect.

Identification of Chemicals of Potential Concern (COPCs)

COPC selection is based on various aspects of chemical occurrence and distribution. Chemicals are selected to represent site contamination and provide the framework for the quantitative risk assessment. COPC selection at Derecktor Shipyard is based on the following rules:

- If the chemical was detected in the evaluated media at a frequency of greater than 5 percent it is included as a COPC. If fewer than 20 samples were collected for a chemical in a medium under consideration, any single detection or greater lead to the inclusion of this chemical as a COPC.
- After developing the candidate list of COPCs, eliminate the essential nutrients including calcium, chloride, magnesium, phosphorus, potassium, and sodium, if they are not present at high concentrations at a site (EPA, 1989a).

A comparison to background concentrations for inorganic chemicals will not be done for shellfish tissue samples because actual background levels of inorganics in shellfish tissue are unknown. Reference station information is available for shellfish tissue, and this information will be presented as an uncertainty in the assessment process. Although this approach does not consider several other factors as discussed in EPA (1989a) (e.g. toxicity, mobility, persistence, bioaccumulation, chemical treatability, available cleanup standards), it is inclusive rather than exclusive in nature and is reasonable for use in this HHRA.

Exposure Point Concentrations (EPCs)

This risk assessment will be performed using two types of exposure point concentrations (EPCs), an average and a maximum concentration. For purposes of this HHRA, the arithmetic mean, rather than the geometric mean, is used as the indicator of central tendency of the site data. Although it is reasonable to assume most environmental data are log-normal, the arithmetic mean is used in the HHRA per verbal guidance from EPA Region I. The arithmetic mean is calculated as follows:

$$X_{ij\bar{}} = \frac{(X_{i1} + X_{i2} + \dots X_{in})}{n}$$

where:

$X_{ij\bar{}}$ = arithmetic mean of all sample concentrations of chemical i in medium j

X_i = the concentration for chemical i in each of n samples

N = the number of samples

The maximum detected concentration of a chemical is also used to assess potential exposures and risks. Exposures estimates based on maximum concentrations are referred to by EPA Region I as estimates of reasonable maximum exposure (RME). The definition of RME differs from the one provided in RAGS (EPA 1989a) which defines RME as the highest exposure that is reasonably expected to occur at a site. In RAGS, the 95 percent upper confidence limit on the arithmetic mean is used as the RME EPC. Use of the maximum concentration can be considered a more

conservative approach which assumes each receptor only comes in contact with the maximum concentration detected in the media of interest and may overestimate the potential risks.

Toxicity Assessment

The purpose of this section is to identify the potential health hazards associated with exposure to each of the COPCs. The literature indicates that the COPCs have the potential to cause carcinogenic and/or noncarcinogenic health effects in humans. Although the COPCs may cause adverse health effects, dose-response relationships and the potential for exposure must be evaluated before the risks to receptors can be determined. Dose-response relationships correlate the magnitude of the intake with the probability of toxic effects. Toxicity information for the COPCs at Derecktor Shipyard will be presented in tabular form and in the form of toxicological profiles. Quantitative toxicity values, Reference doses (RfDs) and slope factors (SFs) have been developed by EPA (1997, 1995) and other sources for many organics and inorganics. The RfD is developed by EPA for chronic and/or subchronic human exposure to hazardous chemicals and is based solely on the noncarcinogenic effects of chemical substances. SFs are applicable for estimating the lifetime probability (assumed 70-year life span) of human receptors developing cancer as a result of exposure to known or potential carcinogens.

Noncarcinogenic and carcinogenic risks for lead will not be quantified by comparison to RfDs because EPA has implemented an approach (using a model) to evaluating lead risks that goes beyond providing a single point estimate output. Instead, expected blood-lead levels are estimated using a biokinetic model designed to estimate expected blood-lead increases.

Chromium will be assumed to be present as the hexavalent chromium (VI) form as opposed to the trivalent form (chromium III) because no speciation data are available.

Exposure Assessment

The purpose of this section is to evaluate the potential for human exposure to the chemicals detected in the shellfish tissue from the study area. This section will characterize the exposure setting, characterize the potentially exposed populations, identify actual or potential exposure routes, present a general conceptual site model, and summarize the methods used to generate exposure estimates.

Ingestion of shellfish (mussels, clams, and lobsters) has been identified as the principal route of human exposure to site contaminants for this study. Potential receptors were selected taking into account that it is expected that Coddington Cove, including the waters near Derecktor Shipyard, while currently under a state-regulated shellfishing ban, will not be physically restricted from use by subsistence fishermen and recreational fishermen. Therefore, the receptors chosen for the assessment of risks from Derecktor Shipyard shellfish consumption have been developed as follows:

- Future adult resident (future shellfishing scenario) - For this scenario, adult residents are assumed to be exposed to site contaminants through the ingestion of shellfish (mussels, clams, and lobsters) obtained from locations near Derecktor Shipyard. Standard EPA (1993) assumptions for exposure frequency and duration under residential land use are used (i.e. 350 days/year, 30 years). The shellfish ingestion rates are 1,200 mg/day for shellfish tissue and are based on an estimate of seafood serving sizes (150,000 mg/meal) and Rhode Island survey data on the number of hard-shell clam meals eaten per year (2.9 meals/year) provided by RIDEM (Narragansett Bay Project, n.d.). This receptor will be evaluated for eating mussels, clams, and lobster separately.
- Future child resident (future shellfishing scenario) - For this scenario child residents are assumed to be exposed to site contaminants through ingestion of shellfish (mussels, clams, and lobsters) obtained from near-shore and off shore locations near Derecktor Shipyard. Standard EPA (1993) assumptions for exposure frequency and duration under residential land use are used (i.e. 350 days/year, 6 years). The shellfish ingestion rates are 396 mg/day for mussels and clams and are based on an estimate of seafood serving sizes (48,000 mg/meal or 32 percent of the adult meal) and Rhode Island survey data on the number of hard-shell clam meals eaten per year (2.9 meals/year) provided by RIDEM (Narragansett Bay Project, n.d.). Child shellfish ingestion rates are not available from either EPA or RIDEM. In order to estimate the child ingestion rates, the ratios of child versus adult seafood ingestion rates from these documents are 26 percent (Rupp, 1980), 33 percent (EPA 1989b), and 38 percent (EPA, 1991a). The resulting average, 32 percent, is considered conservative and appropriate. Applying this average to the ingestion rates for adults yields an average meal size of 48,000 mg/meal for children, rather than the 150,000 mg/meal consumed by adults. This receptor will be evaluated for eating mussels, clams, and lobster separately.

- Future subsistent fisherman (future subsistent fishing scenario) - For this scenario adult subsistent fisherman are assumed to be exposed to site contaminants through ingestion of shellfish (mussels, clams, and lobsters) obtained from near shore and off shore locations near Derecktor Shipyard. Standard EPA (1993) assumptions for exposure frequency and duration under residential land use are used (i.e. 350 days/year, 30 years). The shellfish ingestion rates are 15,600 mg/day for mussels and clams and are based on an estimate of seafood serving sizes (150,000 mg/meal) and Rhode Island survey data on the number of hard-shell clam meals eaten per year (36.5 meals/year) provided by RIDEM. This receptor will be evaluated for eating mussels, clams, and lobster separately.

Conceptual Model:

The conceptual site model for Derecktor Shipyard incorporates information regarding the potential chemical sources, affected media, release mechanisms, routes of migration, and known or potential human receptors. The purpose of the conceptual site model is to provide a framework in which to identify potential exposure pathways occurring at the sites.

The estimation methods and models used in this section are consistent with current EPA risk assessment guidance (EPA, 1989a; EPA, 1991a; EPA, 1996). All exposure scenarios incorporate the representative concentrations in the estimation of intakes. Two types of exposure scenarios are considered in this HHRA, reasonable maximum exposure (RME) and central tendency exposure (CTE). RME incorporates plausible but conservative input parameters into the exposure scenarios that are protective of nearly the entire exposed population excluding less than 5 or 10 percent of the population with abnormally high intake rates, whereas CTE incorporates input parameters that representative of an average exposure scenario.

The equation for exposure to ingestion of shellfish tissue for potential receptors is as follows:

$$ExposureDose(mg / kg / day) = \frac{Conc * IngRate * FI * EF * ED}{BW * AT}$$

where: Conc = Exposure point concentration (either the arithmetic mean or the maximum detected concentration; mg/kg for shellfish tissue)

IngRate = Ingestion rate (mg/day)

FI = Fraction ingested from contaminated source (unitless)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

BW = Body weight (kg)

AT = Averaging time (for carcinogens $< 365 \text{ d/yr} * 70 \text{ yr} = 25,550 \text{ days} >$; for
noncarcinogens $< 365 \text{ d/yr} * ED >$)

The values used for inputs into the above equation are as follows for each receptor:

Receptor	Future Adult Resident	Future Child Resident	Future Subsistent Fisherman
Concentration	Chemical Specific (mg/kg)	Chemical Specific (mg/kg)	Chemical Specific (mg/kg)
Ingestion Rate	1,200 mg/day	396 mg/day	15,600 mg/d
Fraction Ingested	100%	100%	100%
Exposure Frequency	350 days/year	350 days/year	350 days/year
Exposure Duration	30 years	6 years	30 years
Body Weight	70 kg	15 kg	70kg
Averaging Time (carc)	25,550 days	25,550 days	25,550 days
Averaging Time (noncar)	10,950 days	2,190 days	10,950 days

Lead in shellfish is assessed using EPA's Integrated Lead Exposure Uptake/Biokinetic Model (IEUBK, Version 0.99d) (EPA 1994a, b). For this HHRA, default values in the model are used to represent background lead concentrations in air, soil, house dust, water, and the level of maternal contribution. Additionally, the models default values are used to represent respiratory rate, soil, and water ingestion rates, and the percent of lead absorption by various exposure routes. The site-specific factors put into the IEUBK Model are lead concentrations in shellfish and the portion of the diet this represents.

Risk Characterization

Potential human health risks resulting from the exposures outlined in the preceding sections will be characterized on a quantitative and qualitative basis in this section. Quantitative risk estimates will be generated based on risk assessment methods outlined in current EPA guidance (EPA, 1989a).

Noncarcinogenic risk estimates will be presented in the form of Hazard Quotients (HQs) and Hazard Indices (HIs) that are determined through integration of estimated intakes with published RfDs. Incremental cancer risk estimates are provided in the form of dimensionless probabilities based on SFs.

Noncarcinogenic risks will be estimated using the concept of HQs and HIs. The HQ is the ratio of the estimated intake and the RfD for a selected chemical of concern, calculated as follows:

$$HQ = \frac{\text{Intake}}{\text{RfD}}$$

HIs are the sums of the individual HQs for the COPCs. If the value of the HQ or the HI exceeds unity (1.0), the potential for noncarcinogenic health risks associated with exposure to that particular chemical or particular chemical mixture, respectively, cannot be ruled out (EPA, 1986). If the individual HQs are less than 1.0 and the HI is greater than 1.0, particular attention will be paid to the target organ(s) affected by each chemical because these are generally the organ(s) associated with RfD-derived effects, and toxicity for different organs is not truly additive. The HI is not a mathematical prediction of the severity of toxic effects; it is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects.

Incremental cancer risk estimates are generated for each of the exposure pathways using the estimated intakes and published SFs as follows:

$$\text{Risk} = \text{Intake} * \text{SF}$$

The risk determined using these equations is a unitless expression of an individual's increased likelihood of developing cancer as a result of exposure to carcinogenic chemicals. An incremental cancer risk of 1E-06 indicates that the exposed receptor has a one in a million chance of

developing cancer under the defined exposure scenario. Alternatively, such a risk may be interpreted as representing one additional case of cancer in an exposed population of one million persons. The calculated cancer risks should be recognized as upper-limit estimates. SFs are the upper 95 percent confidence limit of a dose-response curve generally derived from animal studies. Actual human risk, while not identifiable, is not expected to exceed the upper limit based on the SFs and may, in fact, be lower.

EPA has generally defined risks in the range of 1E-04 to 1E-06 or less as being acceptable for most hazardous waste facilities addressed under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). For CERCLA activities, residual risks on the order of 1E-06 are the primary goal but are often modified by such regulatory requirements as MCLs or chemical-specific clean-up goals.

EPA's approach to evaluating lead risks goes beyond providing a single point estimate output and incorporates absorption and pharmacokinetic properties. Lead concentrations in shellfish tissue will be assessed for each applicable site for residential children where lead is selected as a COPC using EPA's IEUBK Lead Model (v. 0.99d).

Receptor Risks

Receptor risks will be presented in the form of tables and summary text. Each of these sections will include summaries of risks estimated by the exposure scenarios. Some HQs are not calculable because no RfD has been established. Usually in such cases, carcinogenicity is considered to be more important, since carcinogenicity will generally be seen at lower doses than noncarcinogenic effects. Cancer risks of zero or "N/A" will generally indicate that the chemical is not carcinogenic or that an SF has not yet been developed.

Uncertainty Analysis

Uncertainty Analysis is a discussion of the uncertainties associated with the HHRA. The risk measures used in Superfund site risk assessments are not fully probabilistic estimates of risk but rather are conditional estimates based on a considerable number of assumptions about exposure and toxicity. There are uncertainties associated with each aspect of risk assessment, from environmental data collection through risk characterization.

Uncertainties related to the site physical setting, exposure pathways, and data collection include assumptions regarding in waterway use designation, receptor pathways and shellfishing or dietary intake, selection of locations and numbers of shellfish samples, inability to compare results with samples having naturally occurring background levels, and analytical data uncertainties. Data evaluation uncertainties include the statistical non-representativeness of using the maximum detected value and an approximate exposure point concentration.

Exposure model applicability assumptions include uncertainties in chemical-specific properties, Exposure intake parameter uncertainties are associated with dietary exposure assumptions and shellfish ingestion rates. Toxicity assessment uncertainties include the extrapolations used in computing the published RfDs and SFs, uncertainty in the use of hexavalent chromium RfDs in the absence of speciation data, and uncertainties in the use of toxicity constants that have been withdrawn from the agency database, pending further review and/or verification. Risk characterization uncertainty includes the assumption that non-cancer effects can affect the same target organ in an additive fashion (which may not be true if there are special synergistic or antagonistic interactions) and uncertainties in the assumptions utilized in the estimation of lead risks using EPA's IEUBK model.

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